



Lessons Learned?

Chemical Plant Safety Since Bhopal

It was 3 December 1984, a quiet night in Bhopal, India, until a cascade of catastrophic circumstances, system failures, and outright negligence at the Union Carbide pesticide plant led to the accidental release of approximately 40 metric tons of acutely toxic methyl isocyanate (MIC). The dense cloud of deadly vapor spread over the sleeping community. Estimates of immediate and long-term casualties vary; the U.S. Chemical Safety and Hazard Investigation Board (CSB), an independent federal agency, cites more than 3,000 people dying within a few days and at least 100,000 injured. The event is widely acknowledged to be the worst industrial accident in history, leaving as many as 50,000 people partially or totally disabled as of 1994, according to the International Medical Commission on Bhopal. The incident also left a morass of civil and criminal litigation in its wake, as survivors continue their effort to recover what they consider to be appropriate compensation for their long-term pain and suffering.

As the twentieth anniversary of the Bhopal incident arrives later this year, there inevitably will be a renewed focus on its impact on safety within the chemical industry worldwide. “Bhopal was a wake-up call for the industry,” says chemical engineer Sam Mannan, director of the Mary Kay O’Connor Process Safety Center at Texas A&M University, echoing the opinion of many experts in the field. Although it seems clear that Bhopal has had a positive legacy in improved chemical plant safety, particularly in the United States, to this day there is no single, reliable, quantifiable method to answer a very simple, reasonable, and vitally important question: How safe are chemical plants today, and are they really any safer today than they were 20 years ago?

“I wish somebody had a good solid finger on the pulse of chemical safety, but we really don’t have that in [the United States] right now,” says CSB toxicologist Gerald Poje. Mannan concurs: “It’s really impossible to answer the question ‘Are we doing better or worse?’ without

Digital Vision

having data, without having statistics.” Of that lack of data, he says, “I won’t hesitate to use the word ‘scandalous,’ because it is.”

The Advent of Process Safety

Despite the lack of a definitive, rigorous assessment of chemical safety in the United States, tremendous strides have been made over the past 20 years in culture, practices, and attitudes in the chemical-handling community, as well as in the regulatory environment that governs the industry. If Bhopal was a wake-up call, the call for ongoing improvement in chemical safety has been answered in numerous ways by the industry and many other stakeholders. Disparate groups with diverse agendas are increasingly finding ways to work together in a spirit of cooperation to reduce or prevent accidents, and to enhance the protection of personnel and the public alike.

Perhaps the most important development in those efforts has been the widespread adoption of a concept called process safety. Process safety is a comprehensive, systematic approach encompassing the proactive identification, evaluation, and mitigation or prevention of chemical releases that could occur as a result of failures in process, procedures, or equipment. Although the idea had been in existence before Bhopal, it was the tragedy in India that brought about its complete acceptance as industry standard practice, formalized in 1985 with the creation of the Center for Chemical Process Safety (CCPS) by the American Institute of Chemical Engineers.

The CCPS was founded by a group of chemical companies that recognized the need to establish a professional organization devoted to studying, supporting, and advancing process safety. The CCPS has evolved into a widely respected source of knowledge and expertise in the area. CCPS director Scott Berger says the center’s status as a professional organization lets working on solutions remain the order of the day. “People can just check whatever politics they have at the door,” he says, “and talk like engineers and managers about how to solve real problems.”

The CCPS has published more than 100 books and other information products since its inception. One of its most noteworthy publications was issued in 1989. *Guidelines for Technical Management of Chemical Process Safety* provided the industry with detailed guidance on how to incorporate the process safety concept into its operations. The book

information on incidents, fatalities, injuries, and other parameters. It also proposed indicators and metrics for measuring chemical safety and presented the results of an O’Connor center survey on public trust and community interaction.

The report provided some statistics as well, but they are unavoidably limited in their



A toxic cloud’s silver lining? The 1984 accident at the Union Carbide plant in Bhopal released a toxic cloud that killed and injured thousands. The release was the impetus for an examination of chemical plant safety worldwide and an emphasis on safety measures that continues today.

later served as a basis for federal regulatory oversight of process safety.

At the Mary Kay O’Connor Process Safety

Center, stakeholders in chemical process safety are served through a variety of programs in education, research, and industry service. In 1999, the center convened experts from industry, academia, government, and environmental groups to undertake an ambitious effort called the National Chemical Safety Program. The program’s mission was to establish a rational, objective baseline by which to measure the ongoing status of national chemical industry safety. It culminated in the production of four reports, including the *2001 Assessment of Chemical Safety in the United States*.

The *2001 Assessment* established a framework for prospective quantitative assessment. It included suggested methodologies for analyzing several existing federal databases to yield useful comprehensive

utility. For example, during the eight-year period examined, fatalities and injuries due to all chemicals (as opposed to specific agents or classes) decreased. But the National Chemical Safety Program was unable to normalize its findings by correlating them to industry trends during the period. “We knew on an absolute basis [that fatalities] had gone down,” says Mannan, “but had the total volume of what had been manufactured or processed gone down too, so the normalized numbers would have gone up? We don’t know. Had the total number of people working in the industry gone down as well? We don’t know.”

Despite its inherent limitations, the report did establish a baseline for future comparisons, and the intent was that the status of national chemical safety be assessed annually against that baseline. But the National Chemical Safety Program was unable to secure continued federal funding, and no one else has come forward to provide the necessary support. Mannan still hopes the project will be revived at some point, and is adamant about its

importance. “We are spending millions and billions of dollars on these programs on the industry side and the government side, and yet there’s no way of knowing what the [overall status of national chemical safety] is,” he says. “Somebody has to start doing meaningful data collection and analysis every year,” he adds. “Only then will we know where we’re going and how fast we’re going there.”

The Government’s Role

Regulatory oversight of process safety was codified in 1990, when Congress passed the Clean Air Act Amendments (CAAA) following Bhopal and several other serious domestic and international chemical plant incidents. The legislation has three major provisions impacting chemical safety and gave added authority to the Occupational Safety and Health Administration (OSHA) and the U.S. Environmental Protection Agency (EPA) to regulate the chemical industry.

OSHA was directed to create, promulgate, and enforce the so-called PSM standard—Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119). The PSM standard emphasizes the management of hazards through a comprehensive program that integrates technologies, procedures, and management practices. The standard has 16 elements, 14 of which are mandatory. Mike Marshall, process safety management coordinator in OSHA’s Directorate of Enforcement Programs, says the various management system elements are “fundamental to running a safe chemical operation.”

One key element mandated is the process hazard analysis (PHA), which OSHA’s PSM compliance guidelines define as “an organized and systematic effort to identify and analyze the significance of potential hazards associated with the processing or handling of highly hazardous chemicals.” The PHA leads to the development of operating, maintenance, and training procedures, along with emergency response and incident investigation elements. Compliance audits are also included in the standard, ensuring that non-compliers will face legal consequences such as citations or fines.

Today, the PSM standard is perhaps the main regulatory bastion against abuse or negligence within the chemical industry that could lead to incidents, and has become a routine part of doing business. “What we’ve seen since [implementation of] the PSM standard is that these industries have really evolved,” says Marshall. “It’s not just a concept on paper, and something that they should be doing, but they as an industry have fully embraced the concept now. They don’t see it as a regulation per se, but as good business practice.”

Glenn Erwin, a health and safety coordinator with the Paper, Allied-Industrial,

Chemical, and Energy Workers (PACE) International Union, agrees: “I think the PSM standard was one of the best things that [the government] did. I think if applied properly, if applied within the spirit of how the law was written, that it’s good for us and a good way to manage our business.”

The CAAA also directed the EPA to create its risk management program (RMP) rule (40 CFR 68), which requires companies using certain flammable and toxic substances to develop an RMP that must be revised and resubmitted to the agency every five years. Whereas the PSM standard governs process safety, the RMP rule is aimed more at protecting personnel and surrounding communities from the hazards associated with an accidental release. It emphasizes hazard assessment and prevention measures, and requires the establishment of an emergency response program that includes procedures to inform the public and outside responders in the event of an accident.

The third major provision of the CAAA affecting chemical safety was the establishment of the CSB, which began its activities in 1998. Modeled on the National Transportation Safety Board, the CSB has the primary responsibility for investigating major chemical accidents at fixed facilities (as opposed to accidents involving transportation). Upon completion of an investigation, the board issues a full report, including examinations of root causes and lessons learned from the incident. While it does not have the power to issue citations or fines, it does make detailed safety recommendations to plants, industry organizations, labor groups, and regulatory agencies.

As an independent federal agency, the CSB also goes beyond the scope of individual

investigations from time to time, issuing reports designed to focus wider attention on what it believes to be systemic problems in need of attention. For example, its 2002 report *Improving Reactive Hazard Management* explored concerns about chemical reactivity incidents. The paper contained controversial recommendations that reverberate through the bureaucratic landscape to this day.

A Firestorm over Chemical Reactivity Hazards

“Runaway” exothermic reactions—when a chemical reaction produces heat more rapidly than it can be removed from the system—are often the cause of chemical plant catastrophes. Such was the case on 8 April 1998 at Morton International’s chemical plant in Paterson, New Jersey, when a production run of Automate Yellow 96, a dye used to tint petroleum fuel products, spiraled out of control. The runaway reaction led to an explosion that injured nine workers and a fireball that rained toxic chemicals onto the nearby community.

Although the CSB had been in existence for only a few months, the group had already detected what they considered to be a very troubling pattern in chemical plant incidents: runaway reactions in processes using combinations of chemicals that by themselves are not rated as highly reactive. The Morton incident, among others, triggered the CSB to conduct a major two-year investigation into the role of reactivity hazards in chemical plant incidents, which resulted in the September 2002 release of *Improving Reactive Hazard Management*.

CSB staff examined 167 serious chemical reactivity incidents that occurred in the United States between 1980 and 2001, accidents that had caused 108 deaths, numerous



Reaction and action. A 1998 runaway chemical reaction at the Morton International plant in Paterson, New Jersey, helped call greater attention to this particular industry hazard.

injuries, and hundreds of millions of dollars in property damage. The study found that more than half of the incidents involved chemicals not covered by the OSHA PSM standard or the EPA RMP rule, both of which contain lists of chemicals specifically addressed in the regulations. Nor do the regulations address the issue of combinations of chemicals in specific processes. According to the CSB, these are major gaps in the regulatory framework, gaps the board has vigorously sought to fill. Among the 18 recommendations included in the report, the board formally recommended that OSHA and the EPA expand

chemical reactivity, and to enforce existing standards related to chemical reactivity through the General Duty clause of the original 1970 Occupational Safety and Health Act, which gives the agency authority to govern serious recognized hazards not covered by specific OSHA regulations.

True to its word, OSHA has already begun two new educational efforts. On 16 March 2004 the agency announced its new Hazard Communication Initiative, through which it will develop materials to guide chemical manufacturers and importers in developing material safety data sheets, conducting

CSB's investigation strongly indicates that a revision of the standard is necessary. . . . While the Board understands that making a decision to move forward on a new standard or a major revision of an existing standard is difficult, we were disappointed that your letter provided no indication of when a decision may be made, nor did it indicate what criteria OSHA will use to arrive at that decision." The board voted unanimously to formally characterize OSHA's response as "Open—Unacceptable Response," indicating that it will continue to seek action from OSHA on its recommendations.

Another recommendation the CSB made in its report was that the CCPS complete work on a book of guidelines for industry practitioners regarding reactivity hazards. The CCPS did so shortly thereafter, releasing *Essential Practices for Managing Reactive Chemistry Hazards* in April 2003. In March 2004, the CCPS entered into an agreement with OSHA, the EPA, the ACC, and SOCMA to provide funding for the book to be distributed on the Internet at <http://info.knovel.com/ccps/> free of charge. The ACC also plans to work with OSHA, the EPA, the CCPS, and SOCMA to push the information out more broadly within its membership and customer chain, and to customize the material for specific audiences.

In contrast to the broader issue of chemical safety, there is plenty of information on reactivity hazards, but it often is not in the right hands at the right times to prevent accidents. "One of the findings in the CSB report was that it wasn't that there was a lack of information, but that people didn't know how to access it and how to use it," says Dorothy Kellogg, leader of the ACC plant operations team. "This alliance has been formed to help address those fundamental findings in the CSB report."

Although there is much praise for the CCPS's book, the public-private partnerships created to widely disseminate it, and other ongoing professional outreach activities, some experts think more needs to be done to ensure prevention of chemical reactivity incidents. Erwin says that although the CCPS does a good job and publishes excellent material, their recommendations are not mandatory, and there are no consequences to not following them. He feels strongly that regulatory muscle is a necessary component. "There need to be the guidelines, then there needs to be some enforcement . . . and that's where we disagree with the American Chemistry Council," he says. "They think there doesn't need to be any enforcement. You just put out the guidelines, and we're all good scouts, and everybody follows the rules. That's just not the case."

Erwin is also critical of OSHA's stance on the issue: "We've had enough incidents, we've had enough people killed, and it's just not on



Sampling safety.

their regulations to include more comprehensive coverage of reactivity hazards resulting from process-specific conditions and combinations of chemicals.

But some parties—especially OSHA—don't agree that expanding regulatory coverage is the appropriate way to improve safety and prevent incidents. In the agency's formal response to the CSB's recommendations on 13 November 2003, John Henshaw, the Department of Labor assistant secretary for occupational safety and health, wrote that "OSHA has not yet decided whether to amend the PSM standard," citing the fact that the agency believes "there is no consensus on the part of experts on the best approach that should be taken with regard to reactivity hazards."

While acknowledging that reactivity hazards are a serious problem, Henshaw explained that rather than expanding the PSM standard, OSHA prefers another approach. The agency plans to increase outreach activities to enhance awareness of the hazards associated with

employee safety training, and assessing published data to determine chemical hazards. And on 30 March 2004, OSHA announced a new alliance with the EPA, the American Chemistry Council (ACC), the CCPS, the Chlorine Institute, the O'Connor center, the National Association of Chemical Distributors, and the Synthetic Organic Chemical Manufacturers Association (SOCMA) to educate workers about chemical reactivity hazards. Alliance members will furnish the expertise for conducting reactivity hazard training at conferences and meetings as well as through courses offered by OSHA's Training Institute Education Centers. Each member will also develop and disseminate print and electronic educational materials and tools on its website.

But the CSB remains convinced that regulatory updates are critical if reactivity hazards are truly to be combated. In a 4 February 2004 retort to OSHA's November memorandum, the board wrote that "Board members continue to believe that the evidence compiled by the

this administration's agenda. . . . From our standpoint, OSHA's not going to do anything, and it needs to happen."

Mannan disagrees. Although the O'Connor center has published around 50 papers on issues related to chemical reactivity, he insists that the science is not yet to a point where legislators can write a chemical reactivity regulation that would work or be enforceable. He feels that education and communication of existing knowledge will be more effective. Of the CSB's 167 incidents, he says, the majority could have been addressed by very simple screening techniques, already available in the published literature, that could work in most chemical reactivity situations. "But people are just not using them," he says, "and no kind of regulation is going to solve that unless you put a policeman in every plant."

Despite the controversy, Poje remains optimistic about the situation. "One can't confront, as the board has to confront, deadly tragedies involving reactive hazards and believe that we can hold to the status quo," he says. "And I can't be negative in my projections of the future." He cites action recently taken by the New Jersey Department of Environmental Protection as evidence that the tide is turning in favor of increased regulatory scrutiny. In 2003, New Jersey added chemical reactivity to the list of hazards that trigger risk management planning requirements under the state's Toxic Catastrophe Prevention Act. Poje says he has pointed out to many of his colleagues, including those at OSHA, that New Jersey's policy decision "would be a wonderful way to study how one state has already enabled itself to address reactive hazards in a fashion better than their regulation originally portended." Whether New Jersey's action will inspire broader national policy remains to be seen.

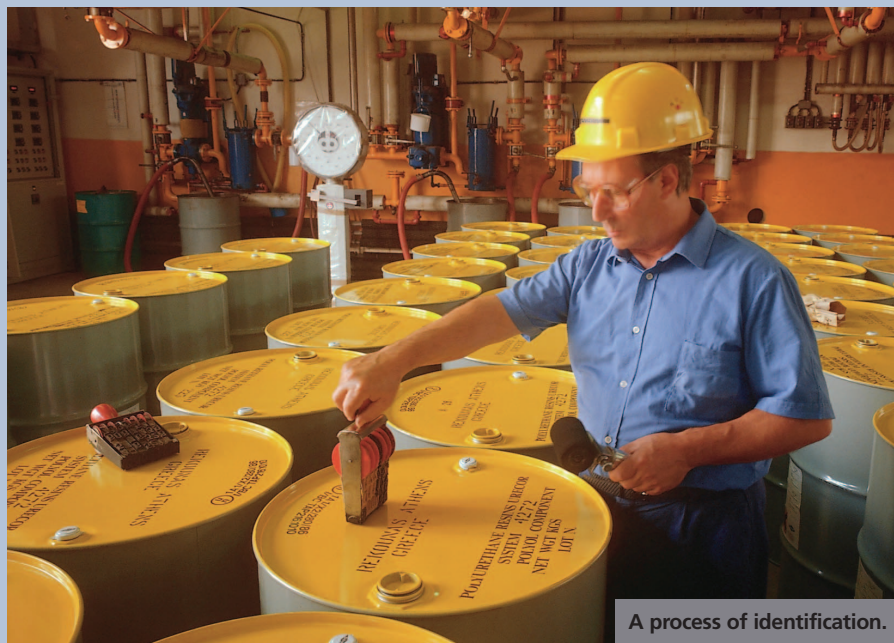
Private Sector Initiatives

As the chemical industry and the governmental regulations that oversee it have matured, so has the industry's appreciation of the importance of safety and its impact on both the bottom line and the sector's public image. "There's no money to be made in accidents," says Kellogg. "We're always looking for ways and tools to improve the safety of our operations."

The ACC, whose 140 member companies represent approximately 90% of the nation's productive capacity for chemicals, points with pride to its Responsible Care program. Launched in 1988 when the ACC was still known as the Chemical Manufacturers Association, Responsible Care commits companies to meeting specific environmental, health, safety, and security performance criteria as a condition of membership. In 2002, the ACC updated the program, replacing its former Codes of Management Practice with a new

framework called the Responsible Care Management System (RCMS).

The RCMS strengthens the program's commitment to continuous improvement, and implements tougher performance requirements along with an independent third-party verification process. "It requires companies to address process safety issues throughout the process," says Debra Phillips, managing director of the program. "There is a continuous improvement requirement built in that companies audit and evaluate effectiveness, investigate incidents, have a system in place to evaluate findings, extend those findings to other areas within their organization, and then build on that."



A process of identification.

To assure that these best practices are in fact practiced, beginning this year each company is required to submit information to the ACC concerning 11 different performance measures, including environmental safety and health performance, security, product issues, and distribution practices. In an effort to increase transparency and public accountability, a subset of the measures submitted by each company will be made available to the public in the near future.

Under the new RCMS, member companies must also pass an audit conducted by a trained, independent third party. The audit is based on detailed ISO 14001 technical specifications with additional specifications pulled from Responsible Care. It is designed to certify that a company has implemented all the elements of the RCMS. Certification is a pass/fail process, and passage is a condition of membership in the ACC.

Poje thinks such actions are an important factor in maintaining the integrity of the

overall system of safety. "We need to have some degree of independent oversight to keep ourselves rigorous in our approaches toward managing facilities that handle highly hazardous materials," he says. "If you don't have that, you're going to run the risk that a few people will do the wrong thing even though they know the right thing is mandated." The first round of RCMS certification audits is due to be completed in September 2005.

The ACC also credits Responsible Care with what it reports to be a dramatic improvement in employee health and safety in member companies. It cites a 16% improvement in overall safety among member company employees in 2002 over the previous year, and

a 42% improvement since 1993. An ACC news release of 5 August 2003 also stated that based on statistics gathered by the federal government, workplaces at member companies in 2001 were approximately four times safer than the combined average of all U.S. manufacturing industries and twice as safe as the chemical industry as a whole.

As the major labor union representing U.S. chemical workers, the PACE International Union in 1996 instituted its own health and safety initiative, known as the Triangle of Prevention (TOP). Designed to be a cooperative effort among the international union, local branches of the union, and corporate management, the three sides of the triangle represent the critical elements of the program: measuring and tracking incidents, systems of safety training, and union leadership. According to Erwin, who is project director for TOP, the program is a systems approach to managing health and safety in the workplace.



Safer pharmaceutical production.

The TOP program educates all employees at participating facilities to recognize that all incidents are caused by systems failures in any of six areas: design and engineering, maintenance and inspection, mitigation devices, warning devices, training and procedures, and human factors. Workers are trained to employ an objective, rule-based, logic tree methodology to investigate incidents and determine root causes, as well as to arrive at specific solutions to specific problems in order to prevent future incidents and near-misses. The program also uses a mechanism known as Lessons Learned to share information among facilities, so that safety and prevention experience reaches operators directly. “If we learn a lesson at one site, then we’ll post it on our website,” says Erwin. “All of our member [facilities] do at least two Lessons Learned a year. The ones that have the lowest rates and the safest plants are the ones that do the most.”

Another important element of the program is the TOP Index, which measures a facility’s safety based not only upon rates of certain injuries that must be reported to OSHA (these rates are often viewed as a standard index of industrial workplace safety), but also upon the occurrence of a variety of incidents and near-misses, as well as actions taken to fix or prevent problems identified to be root causes. Thus, it tracks, measures, and gives credit to constructive, positive change in the workplace.

To Erwin, the index is a more accurate reflection of overall safety than simple injury reporting, and he says it is widely accepted by the facilities that participate in the TOP program as a valid yardstick of

overall performance. He adds that although incidents have not been eliminated, the amount of human error leading to incidents has been reduced; today the number-one cause of accidents is mechanical failure.

Poje praises the efforts of groups such as the CCPS, the ACC, and the PACE International Union, but still feels that they don’t add up to a comprehensive system to prevent tragedies. “There has to be an awareness and an enthusiasm across the entire chemical-handling community for gaining the knowledge that needs to be had to operate safely,” he says. “Any single professional organization, trade union, or groups of corporations are important pointers to the right direction, but they are not substitutes for the whole of the chemical-handling community getting its act together and operating with the kind of safety that everybody merits.”

What About the Chemicals?

An assessment of the state of chemical safety must, of course, take into account the chemicals themselves—the thousands of compounds to which workers, transporters, and ultimately the public are often exposed. How much do we know about these materials? Which are the most dangerous, and which are cause for less concern? What about long-term, chronic exposures? Is anyone’s finger on the pulse of this aspect of chemical safety?

Again, the answers are unclear. Although much is known about the chemicals in use today, much more remains to be discovered. And although a good deal of research is being conducted on the risks associated with exposures, there is a surprising and disturbing lack

of even basic publicly available information about many of the chemicals most commonly produced in U.S. manufacturing facilities.

That situation came to light in the late 1990s, when three studies—*Toxic Ignorance* by Environmental Defense, the EPA’s *Chemical Hazard Data Availability Study*, and the Chemical Manufacturers Association’s *Public Availability of SIDS-Related Testing Data for U.S. High Production Volume Chemicals*—all showed that even basic screening-level data on human and environmental hazards were not available for most of the chemicals produced in large volumes in the United States. These “high production volume” (HPV) chemicals, which are defined as those produced in amounts exceeding 1 million pounds annually, account for more than 90% of the total volume of chemicals manufactured and used. *Toxic Ignorance* noted that “the public cannot tell whether a large majority of the highest-use chemicals in the United States pose health hazards or not—much less how serious the risks might be, or whether those chemicals are actually under control.”

The three groups, having called attention to this serious gap in knowledge, proceeded to jointly develop an initiative designed to fill that gap. Launched in 1998, the HPV Challenge Program is intended to develop and make public basic hazard screening data on the approximately 2,800 chemicals deemed at that time to be HPV. It calls for individual manufacturers to gather existing data and then sponsor the research necessary to fill the remaining data gaps for their HPV products.

The program adopted as its required data elements the Screening Information Data Set (SIDS) of the Organisation for Economic Co-operation and Development. SIDS includes tests for acute toxicity, chronic toxicity, developmental/reproductive toxicity, mutagenicity, ecotoxicity, and environmental fate. The SIDS results, while covering only a subset of all relevant health end points, will ultimately be used as a screen to identify those chemicals in need of further research into their hazards.

The HPV Challenge Program is due to be completed in 2005, and although there are still several hundred “orphan” chemicals that were not sponsored, officials are optimistic that the deadline will be met for most HPV chemicals and that the orphan chemicals will be addressed at some point. Perhaps the most important element of the program is the fact that all of the information will ultimately be made public in an Internet-accessible database. “The power of information is really the essence of the program,” says Ward Penberthy, associate director of the Chemical Control Division in the EPA Office of Pollution Prevention and Toxics. “The whole premise is public availability of the data.”

Senior scientist Richard Denison of Environmental Defense also sees public

disclosure as the key to the program's success. "That is where the rubber ultimately hits the road," he says. "All of the players have a vested interest or a reason to want this information to be made public: not just the public, but industry players, government officials, academics, purchasing officials in companies, all of the people that might have an interest in understanding more about the chemicals that they use or are exposed to, or the products that contain those chemicals."

Although the data sets fall well short of providing comprehensive information about any particular chemical, the power of the project will be to aid prioritization of further work that needs to be done—which chemicals deserve more research, and which can be considered lower priority. "I think it will serve as a funnel to allow the targeting of resources in academia, in government, in industry, and in environmental organizations, to focus on those chemicals that look like they warrant the most scrutiny first," says Denison.

Industry-Supported Research

Despite the apparent dearth of knowledge uncovered in the public domain by the originators of the HPV Challenge Program, there is obviously an enormous amount of research into chemicals and the hazards they represent being conducted in governmental, academic, and industrial laboratories around the world. The chemical industry itself has long recognized its obligation to support research into the potential impacts that chemicals may have on the health of humans, wildlife, and the environment.

For over 25 years the ACC has supported the CIIT Centers for Health Research of Research Triangle Park, North Carolina, a respected facility in environmental health research. More recently, in 1998 the ACC established the Long-Range Research Initiative (LRI), which awards research contracts to independent third-party institutions through a competitive request-for-proposals process. The program, which as of 2003 consisted of 67 active projects, focuses on three areas of particular interest: methods (improving health and ecological effects screening and testing, human exposure testing methods, determinants of dose response), susceptible populations (exploring differences in biologic sensitivity and exposure), and chemicals in the environment (human exposure assessment and analysis, ecosystem exposure analysis).

The LRI actively seeks to support programs that are complementary to or collaborative with organizations such as the NIEHS and the EPA. One such project commenced in 2001 with a memorandum of understanding between the ACC and the NIEHS. With

contributions of \$1 million and \$3 million respectively, 14 grants have been funded to develop methods for understanding the potential effects of chemicals on human reproduction and fetal and childhood development.

So Where Are We?

Industry, government, academia, and environmental groups are all doing their parts to further scientific knowledge about chemicals in the production stream and the potential hazards they represent in both acute and chronic exposures. Perhaps integrative measures such as the HPV Challenge Program will indeed contribute significantly to prioritizing those disparate efforts, so that risks can be minimized without compromising the undeniable benefits that chemicals provide to our economy and to our society. As Denison puts it, "So much of the debate around chemicals is based on either haphazard or piecemeal information. . . . And the result has been that we sort of lurch from one problem to another,

or one chemical incident to another, rather than systematically tackling the problem in a way that allows us to understand where the real risks are, where we should be focusing the most attention."

Are chemical plants and the chemicals they produce and use safer today than they were 20 years ago, when Bhopal sounded its tragic wake-up call? No one can say for sure. Given the significant strides made over the past two decades, there is a strong temptation to answer that question at least tentatively in the affirmative. Attitudes have evolved, culture has progressed, technologies have matured, and a more cooperative, collaborative atmosphere has emerged. There is ample reason for optimism. But as long as issues such as managing chemical reactivity remain unresolved, it seems likely that the day when incidents are reduced to zero is still far away.

Ernie Hood

Toward Safer Chemical Plants

Responsible Care Management System (RCMS)

WHO: American Chemistry Council

WHAT: Member companies must submit information to the American Chemistry Council regarding 11 different performance measures, including environmental safety and health performance, security, product issues, and distribution practices, and pass an independent audit to certify that they have implemented all the elements of the RCMS.

WHERE: <http://www.americanchemistry.com/>

Long-Range Research Initiative (LRI)

WHO: American Chemistry Council

WHAT: LRI awards research contracts to independent research institutions in three areas: methods (improving health and ecological effects screening and testing, human exposure testing methods, determinants of dose response), susceptible populations (exploring differences in biologic sensitivity and exposure), and chemicals in the environment (human exposure assessment and analysis, ecosystem exposure analysis).

WHERE: <http://www.uslri.org/>

Triangle of Prevention (TOP)

WHO: Paper, Allied-Industrial, Chemical, and Energy Workers International Union

WHAT: TOP trains workers at union facilities to use an objective, rule-based, logic tree methodology to investigate incidents and determine root causes, as well as to arrive at specific solutions to specific problems, in order to prevent future incidents and near-misses.

WHERE: <http://pacehealthandsafety.org/TOP/Main.htm>

HPV Challenge Program

WHO: U.S. Environmental Protection Agency, American Chemistry Council, Environmental Defense

WHAT: The HPV Challenge Program aims to gather and make public basic human and environmental screening hazard data including acute toxicity, chronic toxicity, developmental/reproductive toxicity, mutagenicity, ecotoxicity, and environmental fate on the approximately 2,800 chemicals deemed to be high production volume (HPV).

WHERE: <http://www.epa.gov/chemrtk/volchall.htm>

Hazard Communication Initiative

WHO: Occupational Safety and Health Administration

WHAT: The recently announced Hazard Communication Initiative will aid compliance with the agency's Hazard Communication Standard through education on preparing material safety data sheets, developing employee safety programs, and translating published guidance into useful hazard communication materials.

WHERE: <http://www.osha.gov/SLTC/hazardcommunications/index.html>